FK Littorina 07/08 2013
(27.07.-04.08.2013)

Cruise Report / Fahrtbericht

Vom Sediment zum Topp-Prädator – Einfluss von Eigenschaften des Meeresbodens auf Benthos und benthivore Vögel
Teilprojekt STopP-See

Institut für Geowissenschaften
Sedimentologie, Küsten- und Schelfgeologie

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1. Objective of the cruise

The cruise was carried out in the frame of the BMBF-funded project STopP (Vom Sediment zum Topp-Prädator – Einfluss von Eigenschaften des Meeresbodens auf Benthos und benthivore Vögel). The objective was to collect high resolution hydroacoustic data of the geological structure and physical properties of the seabottom sediments in the STopP-Sea area around Amrumbank (North Sea) (see fig. 1). This knowledge will be used to improve the understanding of the interrelation between sea surface and subsurface properties associated with benthic organisms and their influence as source of food for sea birds.

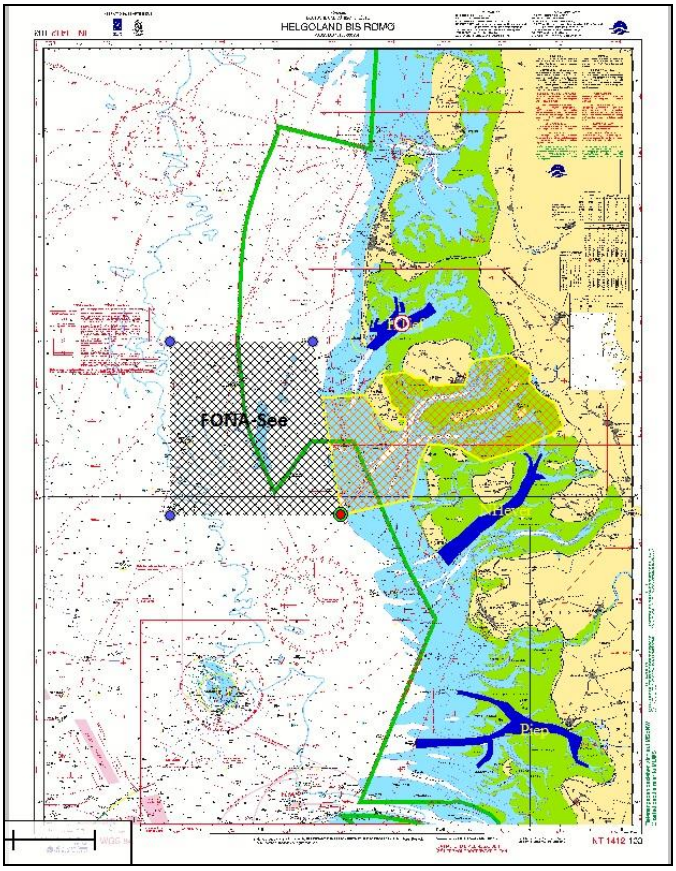

Figure 1: Working areas STopP-subtidal (FONA-See) and STopP-intertidal under investigation of IFG and FTZ Büsum

2. Abbrevations used in this report:

C3D - Side-Scan Sonar (towed)	**SSS**
C3D - Subbottom Profiler (towed)	**SBP**
1624 - Side-Scan Sonar (towed)	**SSS 1624**
Multibeam Echosounder (hull mounted)	**MB**
Innomar Subbottom Profiler (hull mounted)	**SES**
Grab Sampler	**GS**
Underwater Video	**UWV**
CTD	**CTD**

3. Participants of the cruise:

1. **Dr. Klaus Schwarzer** (chief scientist), Inst. of Geosciences, Kiel University
2. **Kerstin Wittbrodt** (scientist), Inst. of Geosciences, Kiel University
3. **Helmut Beese** (technician), Inst. of Geosciences, Kiel University

4. CRUISE NARRATIVE

Sa. 27.07.2013

Weather:	cloudy, 3
05:20	Departing Büsum (SH), heading for working area
09:30	Deployment of devices (SSS, SES, SBP), profiling
10:00-00:00	During the night hydroacoustic profiling with SSS, SES, SBP, MB

Su. 28.07.2013

Weather	cloudy-partly sunny, 4-5
00:00-10:42	Hydroacoustic profiling with SSS, SBP, SES, MB
10:45	Interruption of profiling due to bad weather conditions, devices out of water
11:15	CTD profile, transit to Helgoland
15:00	Arrival Helgoland

Mo. 29.07.2013

Weather:	sunny-partly cloudy, 4, squalls 5
05:15	Departing Helgoland, heading for working area
07:45	CTD profile
07:55	Deployment of devices (SSS, SBP, SES), profiling
08:15-00:00	During the night hydroacoustic profiling with SSS, SBP, SES, MB

Tu. 30.07.2013

Weather:	cloudy, SW 5
00:00-06:04	Profiling with SSS, SBP, SES, MB, interruption of measurements due to bad weather conditions
06:15	Devices out of water, transit to Helgoland
09:00	Arrival Helgoland

We. 31.07.2013

Weather:	sunny, W-SW 5
	Helgoland harbour, no measurements due to bad weather conditions

Th. 01.08.2013

Weather:	cloudy, rainshowers, SW 4
05:15	Departing Helgoland, heading for working area
07:20	Start of grab sampling
08:36	Underwater Video station
10:33	Underwater Video station
10:51	Underwater Video station
13:00	End of grab sampling, transit to Helgoland
16:00	Arrival Helgoland

Fr. 02.08.2013

Weather:	sunny, SE 3-4
05:18	Departing Helgoland, heading for working area
10:30	Start of grab sampling
11:21	Underwater Video station
11:53	Underwater Video station
12:27	Underwater Video station
15:00	End of grab sampling, transit to Helgoland
18:45	Arrival Helgoland

Sa. 03.08.2013

Weather:	cloudy-partly sunny, rainshowers, SW 4
05:15	Departing Helgoland, heading for working area
07:25	CTD profile
07:30	Deployment of devices (SES), start of calibration profiles MB
08:40	End of calibration profiles MB
08:45	Deployment of devices (SSS 1624)
08:55	Hydroacoustic profiling with SSS 1624, SES, MB
14:30	Devices out of water, transit to Cuxhaven
19:15	Arrival Cuxhaven

Su. 04.08.2013

05:20	Departing Cuxhaven, transit through Kiel Canal back to Kiel
15:00	Arrival Kiel, IFM pier

Tab. 1: Hydroacoustic profiling

No	Date	Time (UTC)	Latitude	Longitude	Remarks
1	27.07.2013	10:00	54°30.203'	08°00.814'	begin
1	27.07.2013	12:34	54°45.753	08°00.366‘	end
2	27.07.2013	12:39	54°45.860‘	08°00.466‘	begin
2	27.07.2013	15:20	54°29.880‘	08°00.995‘	end
3	27.07.2013	15:23	54°29.994‘	08°01.109‘	begin
3	27.07.2013	18:00	54°45.830‘	08°00.626‘	end
4	27.07.2013	18:04	54°45.825‘	08°00.806‘	begin
4	27.07.2013	20:39	54°30.057‘	08°01.321‘	end
5	27.07.2013	20:43	54°29.935‘	08°01.440‘	begin
5	27.07.2013	23:24	54°45.854‘	08°01.025‘	end
6	27.07.2013	23:28	54°45.913‘	08°01.189‘	begin
6	28.07.2013	02:08	54°29.985‘	08°01.571‘	end
7	28.07.2013	02:12	54°29.997‘	08°01.869‘	begin
7	28.07.2013	04:50	54°45.854‘	08°01.282‘	end
8	28.07.2013	04:56	54°45.849‘	08°01.493‘	begin
8	28.07.2013	07:32	54°30.056‘	08°02.018‘	end
9	28.07.2013	07:36	54°29.991‘	08°02.111‘	begin
9	28.07.2013	10:17	54°45.868‘	08°01.693‘	end
10	28.07.2013	10:21	54°45.847‘	08°01.786‘	begin
10	28.07.2013	12:42	54°43.688‘	08°01.891‘	profile interrupted
10	29.07.2013	10:58	54°45.843‘	08°01.764‘	profile restart
10	29.07.2013	13:36	54°29.992‘	08°02.232‘	end
11	29.07.2013	08:14	54°30.027‘	08°02.487‘	begin
11	29.07.2013	10:54	54°45.858‘	08°02.025‘	end
12	29.07.2013	16:21	54°45.850‘	08°02.102‘	begin
12	29.07.2013	18:57	54°30.077‘	08°02.580‘	end
13	29.07.2013	13:43	54°30.006‘	08°02.863‘	begin
13	29.07.2013	16:17	54°45.853‘	08°02.386‘	end
14	29.07.2013	16:21	54°29.995‘	08°02.963‘	begin
14	29.07.2013	21:41	54°45.872‘	08°02.463‘	end
15	29.07.2013	21:45	54°45.895‘	08°02.649‘	begin
15	30.07.2013	00:20	54°30.008‘	08°03.062‘	end
16	30.07.2013	00:24	54°30.033‘	08°03.356‘	begin
16	30.07.2013	03:01	54°45.872‘	08°02.895‘	end
17	30.07.2013	03:05	54°45.846‘	08°02.953‘	begin
17	30.07.2013	06:04	54°30.055‘	08°03.519‘	end
18	03.08.2013	08:55	54°29.664‘	08°03.626‘	begin
18	03.08.2013	11:34	54°45.827‘	08°03.190‘	end
19	03.08.2013	11:35	54°45974‘	08°03.207‘	begin
19	03.08.2013	14:26	54°29.972‘	08°03.853‘	end

Tab. 2: Stations Grab Sampling

Station	Date	Time (UTC)	Latitude	Longitude	Waterdepth [m]	Remarks
1	01.08.2013	07:18	54°30.23450‘	8°3.22667‘	18.50	
2	01.08.2013	07:56	54°30.29000‘	8°2.08300‘	16.50	
3	01.08.2013	08:08	54°31.52334‘	8°1.30000‘	15.10	
4	01.08.2013	08:18	54°32.61667‘	8°1.95000‘	14.30	
5	01.08.2013	08:27	54°33.04200‘	8°2.95417‘	17.02	
6	01.08.2013	08:47	54°33.58167‘	8°1.93134‘	14.80	
7	01.08.2013	08:54	54°33.77783‘	8°1.92250‘	16.00	
8	01.08.2013	09:08	54°33.78983‘	8°1.76450‘	13.40	
9	01.08.2013	09:17	54°33.49467‘	8°1.76450‘	12.30	
10	01.08.2013	09:57	54°33.21267‘	8°0.96817‘	10.00	
11	01.08.2013	10:11	54°34.55883‘	8°1.21667‘	11.53	
12	01.08.2013	10:17	54°34.68333‘	8°1.17167‘	11.30	empty, second trial
	01.08.2013	10:21	54°34.68334‘	8°1.17168‘	11.30	
13	01.08.2013	10:27	54°34.95333‘	8°1.34050‘	12.80	
14	01.08.2013	10:44	54°34.75130‘	8°2.85710‘	15.40	
15	01.08.2013	11:03	54°35.61233‘	8°2.28270‘	14.80	
16	01.08.2013					no sample taken
17	01.08.2013	11:12	54°36.13930‘	8°1.80660‘	13.60	
18	01.08.2013	11:26	54°36.53040‘	8°2.79580‘	14.70	
19	01.08.2013	11:35	54°36.49840‘	8°2.20500‘	14.30	
20	01.08.2013	11:44	54°36.45540‘	8°0.65000‘	8.30	stone, no sediment
	01.08.2013	11:48	54°36.45541‘	8°0.65001‘	8.30	
21	01.08.2013	12:00	54°37.66040‘	8°0.78580‘	8.30	
22	01.08.2013	12:12	54°37.22600‘	8°1.18260‘	13.30	
23	01.08.2013	12:21	54°37.86760‘	8°2.89850‘	12.80	
24	01.08.2013	12:29	54°38.39767‘	8°2.34340‘	13.00	
25	01.08.2013	12:37	54°38.23267‘	8°1.63600‘	10.80	
26	01.08.2013	12:43	54°38.37990‘	8°1.72917‘	11.50	empty, second trial
	01.08.2013	12:45	54°38.37990‘	8°1.72917‘	11.50	
27	01.08.2013	12:57	54°39.32567‘	8°2.38300‘	12.30	
28	02.08.2013	08:39	54°40.28917‘	8°2.94050‘	12.50	
29	02.08.2013	08:45	54°40.90450‘	8°2.86800‘	13.50	
30	02.08.2013	08:45	54°39.81150‘	8°0.57200‘	13.70	
31	02.08.2013	09:09	54°40.18333‘	8°0.56667‘	14.60	
32	02.08.2013	09:20	54°41.38417‘	8°1.13683‘	14.30	
33	02.08.2013	10:00	54°41.50783‘	8°0.75500‘	14.20	
34	02.08.2013	10:14	54°42.41183‘	8°2.80600‘	13.90	
35	02.08.2013	10:25	54°42.5775‘	8°0.647‘	13.50	
36	02.08.2013	10:38	54°43.52250‘	8°1.12267‘	14.50	empty, second trial
	02.08.2013	11:38	54°43.51500‘	08°1.1302‘	14.50	
37	02.08.2013	10:57	54°43.49500‘	8°1.11817‘	14.50	
38	02.08.2013	11:05	54°43.47530‘	8°1.11250‘	14.20	

39	02.08.2013	11:30	54°43.77467'	8°2.59000'	13.80	
40	02.08.2013	11:43	54°44.81117'	8°2.42000'	13.10	
41	02.08.2013	12:07	54°45.80967'	8°2.51500'	12.00	
42	02.08.2013	12:19	54°45.72467'	8°0.31467'	15.60	
43	02.08.2013	12:51	54°44.22533'	8°0.58884'	14.30	
44	02.08.2013	12:58	54°43.98217'	8°0.70000'	14.00	

Tab. 3: CTD stations

No	Date	Time (UTC)	Latitude	Longitude	Waterdepth [m]
1	28.07.2013	11:15	54°42.994'	08°02.361'	14.0
2	29.07.2013	07:45	54°29.076'	08°02.076'	
3	03.08.2013	07:25	54°27.891'	08°03.233'	19.0

Tab. 4: Video profiles

No	Date	Time [UTC]	Latitude	Longitude	Waterdepth [m]	Action
1	01.08.2013	08:36	54°33.029'	08°02.946'	17.20	start profile
	01.08.2013	08:39	54°33.050'	08°02.946'		end profile
2	01.08.2013	10:33	54°34.9533'	08°01.3405'	12.80	start profile
	01.08.2013	10:36	54°34.9954'	08°01.3466'		end profile
3	01.08.2013	10:51	54°34.5733'	08°02.8485'	15.40	start profile
	01.08.2013	10:54				end profile
4	02.08.2013	11:21	54°43.4667'	08°01.1167'	14.50	start profile
	02.08.2013	11:24				end profile
5	02.08.2013	11:53	54°44.8237'	08°02.4452'	13.10	start profile
	02.08.2013	11:58				end profile
6	02.08.2013	12:27	54°45.7247'	08°00.3147'	15.60	start profile
	02.08.2013	12:36				end profile

5. Methods

The sidescan sonar systems **Teledyne Benthos C3D** and **Benthos 1624** were applied to aquire high resolution hydroacoustic data to prepare maps of the seafloor sediment backscatter characteristics and sediment distribution patterns in the survey area. Both systems were towed behind the vessel with a towing speed of 5 knots. The **Teledyne Benthos C3D** is working in the chirp mode with a frequency of 200 kHz. The **Benthos 1624** in contrast is working with a frequency of 100 kHz as well as 400 kHz. A range of 100 m on each side was applied for both systems. The **Teledyne Benthos C3D** sidescan sonar system has a subbottom profiler included which was used to get simultaneously information about the subsurface characteristics and the geological built-up. Additionally a high resolution sub bottom profiler system (**Innomar-SES**) was used to get further subsurface sediment characteristics.

Multibeam data were collected with the shipboard **SeaBeam 1185** (L3-Communications, ELAC Nautik GmbH) and acquired using the software Hydrostar (L3-Communications, ELAC Nautik GmbH). The operating frequency of the system was 180 kHz. Beside bathymetric data also sidescan data was collected simultaneously with a swath width of 153.5°.

Ground truthing was done by **grab sampling** and **under water video** observations. For the video surveys the underwater video system Mariscope was used.

Tracklines of all hydroacoustic profiles and the position of grab sampling stations are shown in figure 2 and 4. In table 1-4 all stations and profiles of the cruise are listed. These methods were used to get an overview of sediment distribution patterns and sediment properties in the working area, which are decisive for the occurrences and distribution of different benthic species.

6. Preliminary scientific results

The sidescan sonar mosaic resulting from 19 profiles is shown in figure 3. An area of about 102.09 km^2 (29.42 km (N-S) by 3.47 km (E-W), see fig. 3) is covered. The surveyed area is characterized by areas of eye-catching high backscatter values (dark colors) which especially appear in the south-eastern parts, the northern parts and at several smaller sections along the tracklines. The edges of these high backscatter areas were embossed by sharp transitions to low backscatter values (light colors). In the northern parts, areas of striking sediment structures were found which were characterized by small scale alteration of light and dark areas of backscatter values (see fig. 3A, 3B and 3C). These structures could be identified as so called "sorted bedforms" (Cacchione et al. 1984, Diesing et al. 2006), which are highly elongated patches of rippled coarse sand, which tend to be tens to hundreds of meters wide and hundreds to thousands of meters long (Cacchione et al. 1984; Goff et al. 2005). These sediment structures, which are approximately shore perpendicular, are slightly depressed by up to 1 m with respect to surrounding seafloor. They can be clearly identified in sidescan sonar backscatter (Goff et al. 2005). Typically they can be found in nearshore areas where sediment supply is low (Cacchione et al.1984, Murray & Thieler 2004).

Based on the sidescan sonar mosaic, sediment sampling was carried out at 44 stations (see fig. 4 and 5). In figure 8 a-r the grain size distributions of already analyzed grab samples stations are shown. In figure 4 and 5 some pictures of these grab samples and their locations in the survey area are shown. Especially the grab sample pictures of station 5, 32 and 39 present the occurrence of the benthic organism *Lanice conchilega* which obviously was responsible for the eye-catching high backscatter values (Degraer et al. 2008, Heinrich et al. 2013, submitted) in especially the south-eastern and northern parts of the working area. The populations of *Lanice conchilega* also were found in the underwater video profiles and did show dense population in some areas (screenshots see fig. 7). In figure 6 some of the screenshots of the underwater video stations are shown in connection with the sidescan sonar mosaic. In these video profiles, sediment structures which were found in the sidescan sonar mosaic in the northern parts were also visible (see station 40 fig. 6). In figure 5 the grain size distribution from areas with dense population and none population of *Lanice conchilega* is shown. As there is no big difference in the grain size distribution of these stations (see station 5 and 40) the differences in backscatter strength are obviously induced by the *Lanice conchilega* populations (Degraer et al. 2008).

Besides sidescan sonar measurements and grab sampling subbottom profiler data were collected to get information of the sedimentological built-up and thickness of layers in the working area.

7. References

Cacchione, D.A., Drake, D.E., Grant, W.D. & Tate, W.B. (1984): Rippled scour depressions on the inner continental shelf off central California. Journal of Sedimentary Petrology 54, 1280–1291.

Degraer, S., Moerkerke, G., Rabaut, M., Van Hoey, G., Du Four, I., Vincx, M., Henriet, J.P. & Van Lancker, V. (2008): Very-high resolution side-scan sonar mapping of biogenic reefs of the tube-worm *Lanice conchilega*. Remote Sensing of Environment 112, 3323-3328.

Diesing, M., Kubicki, A., Winter, C., Schwarzer, K., (2006): Decadel stability of sorted bedforms, German Bight, southeastern North Sea. – Continental Shelf Research, 26, 902 – 916.

Goff, J.A., Mayer, L.A., Traykovski, P., Buynevich, I., Wilkens, R., Raymond, R., Glang, G., Evans, R.L., Olson, H. & Jenkins, C. (2005): Detailed investigation of sorted bedforms, or ‘‘rippled scour depressions’’, within the Martha’s Vineyard Coastal Observatory, Massachusetts. Continental Shelf Research 25 (4), 461–484.

Heinrich, C., Feldens, P., Schwarzer, K., (2013): Impact of the tubeworm *Lanice conchilega* on the interpretation of side scan sonar backscatter data - submitted to Continental Shelf Research.

Murray, A.B. & Thieler, E.R. (2004): A new hypothesis for the formation of large-scale inner-shelf sediment sorting and ‘rippled scour depressions’. Continental Shelf Research 24, 295–315.

8. Appendices

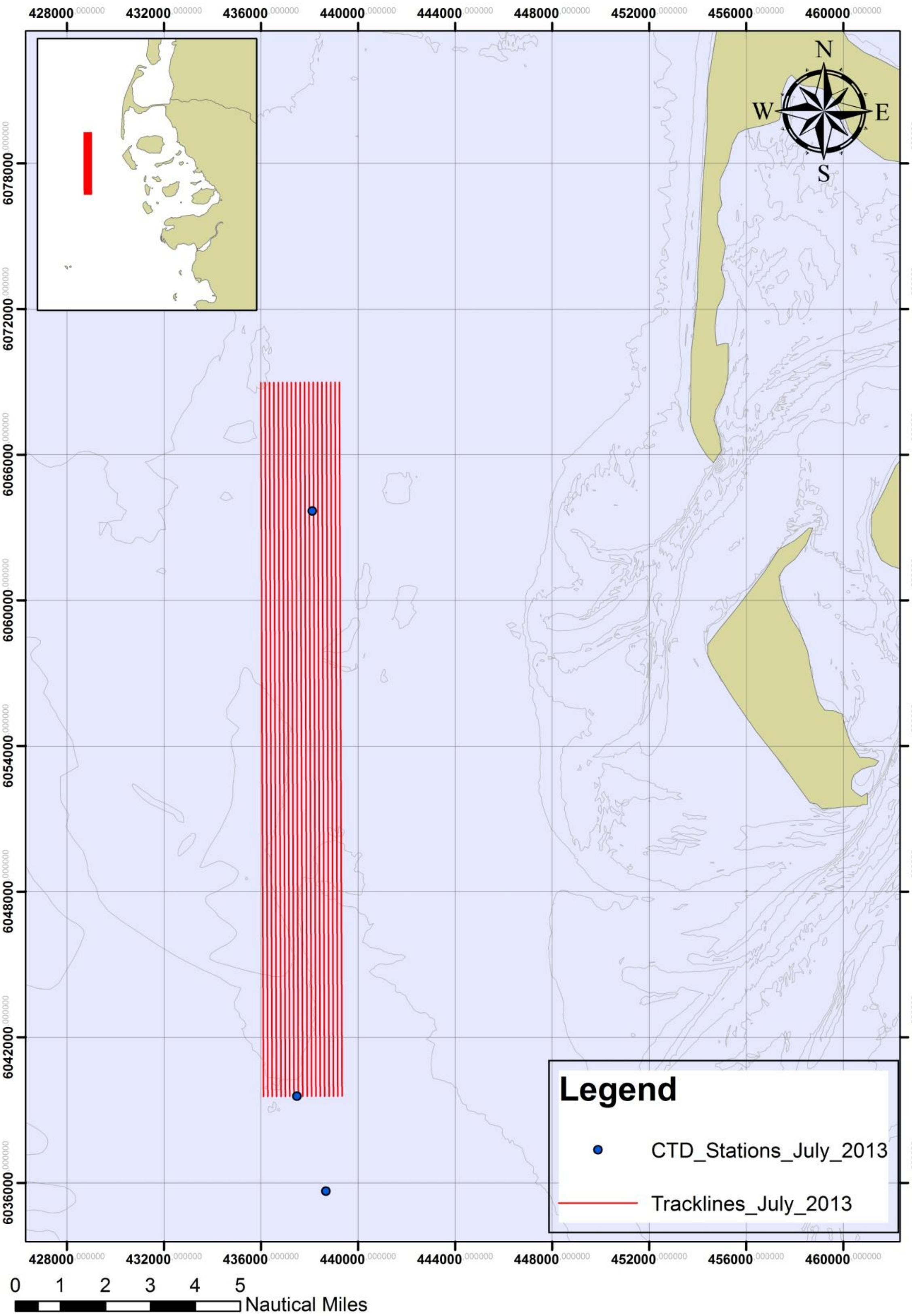

Figure 2: Location and overview of cruise profiles. Blue circles mark stations where CTD measurements were made

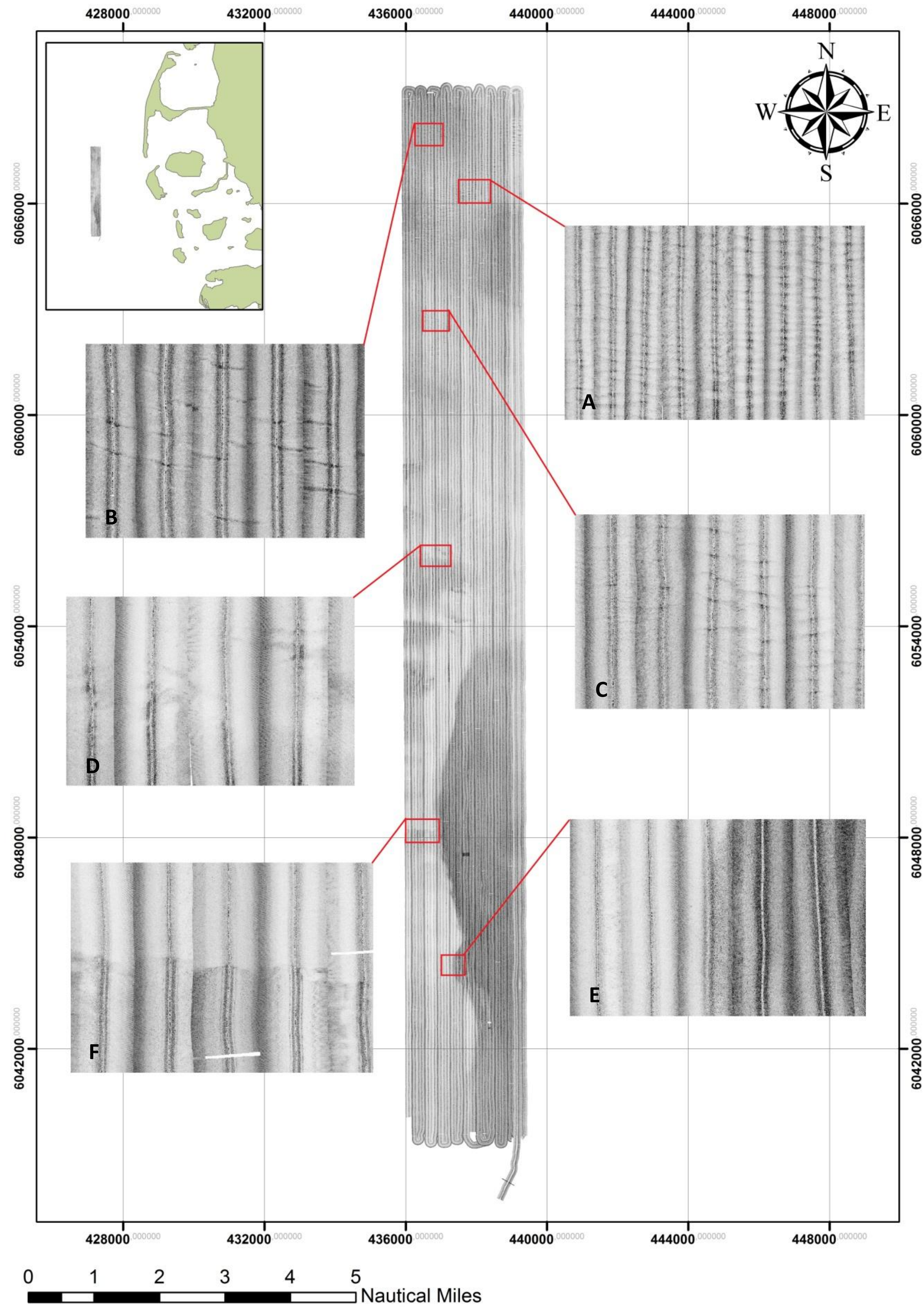

Figure 3: Side-scan mosaic with details of eye-catching sediment structures/transitions

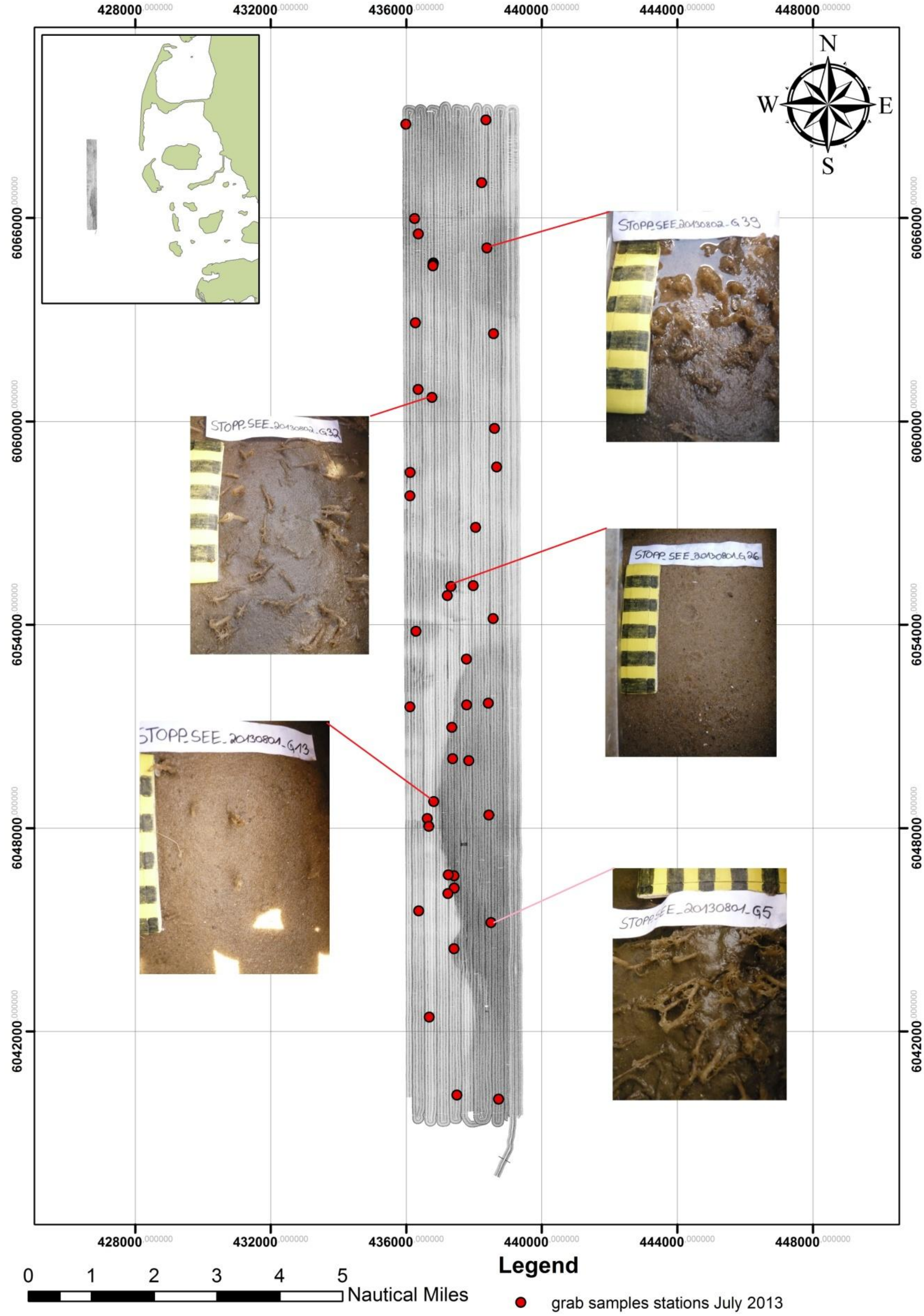

Figure 4: Side-scan mosaic, grab samples stations and example of grab samples pictures

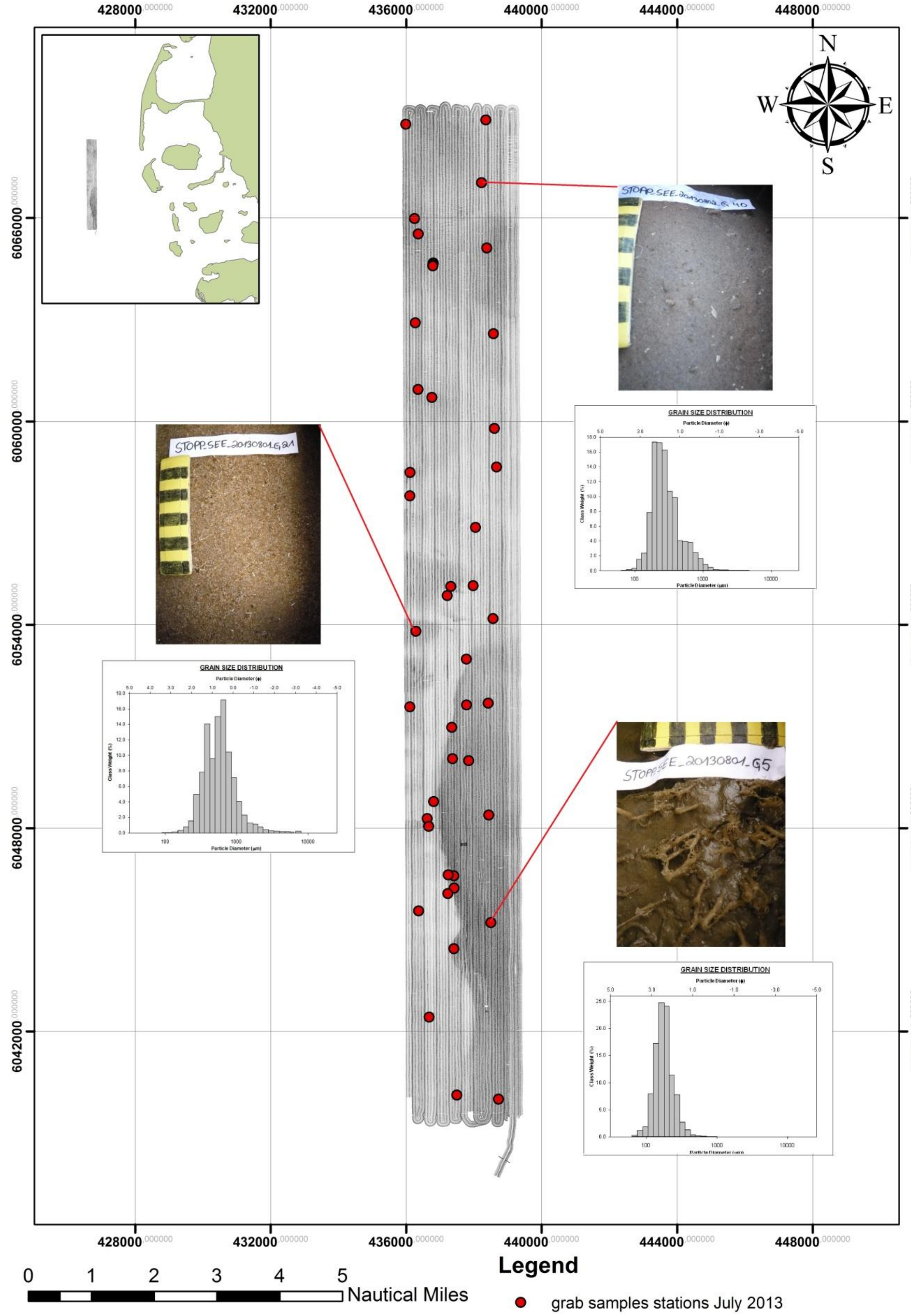

Figure 5: Side-scan mosaic, grab samples stations and example of grab samples pictures connected to grain size analysis

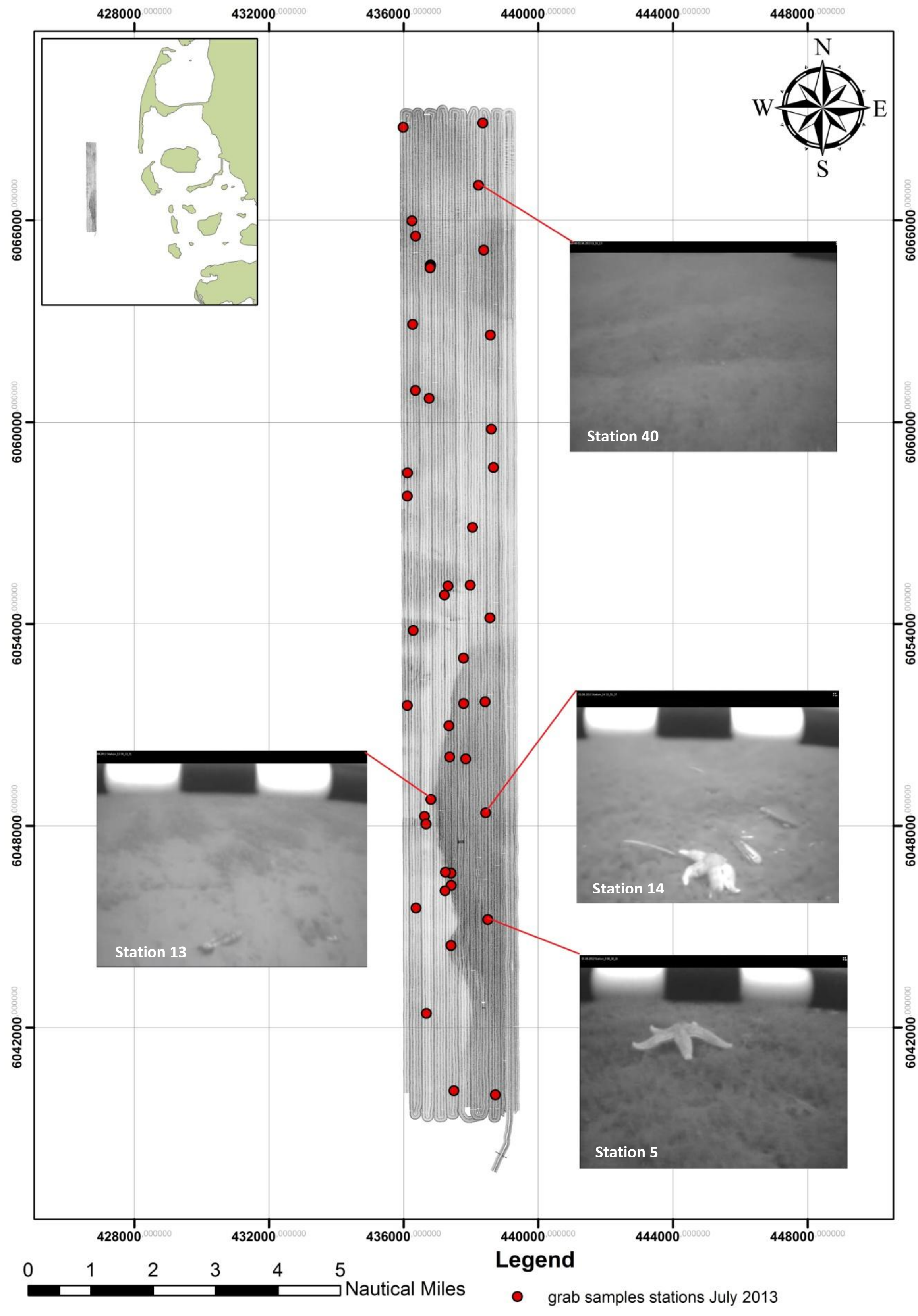

Figure 6: Side-scan mosaic, grab samples stations and video screenshots at specified grab samples stations

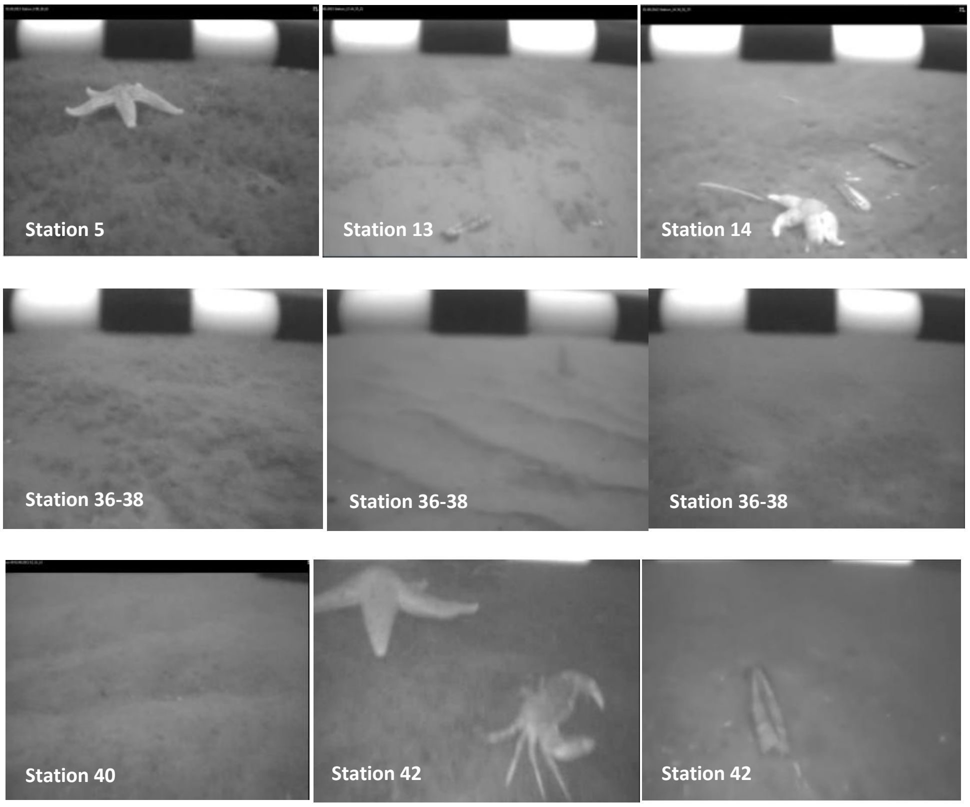

Figure 7: Screenshots of video at grab samples stations 5, 13, 14, 36-38, 40 and 42

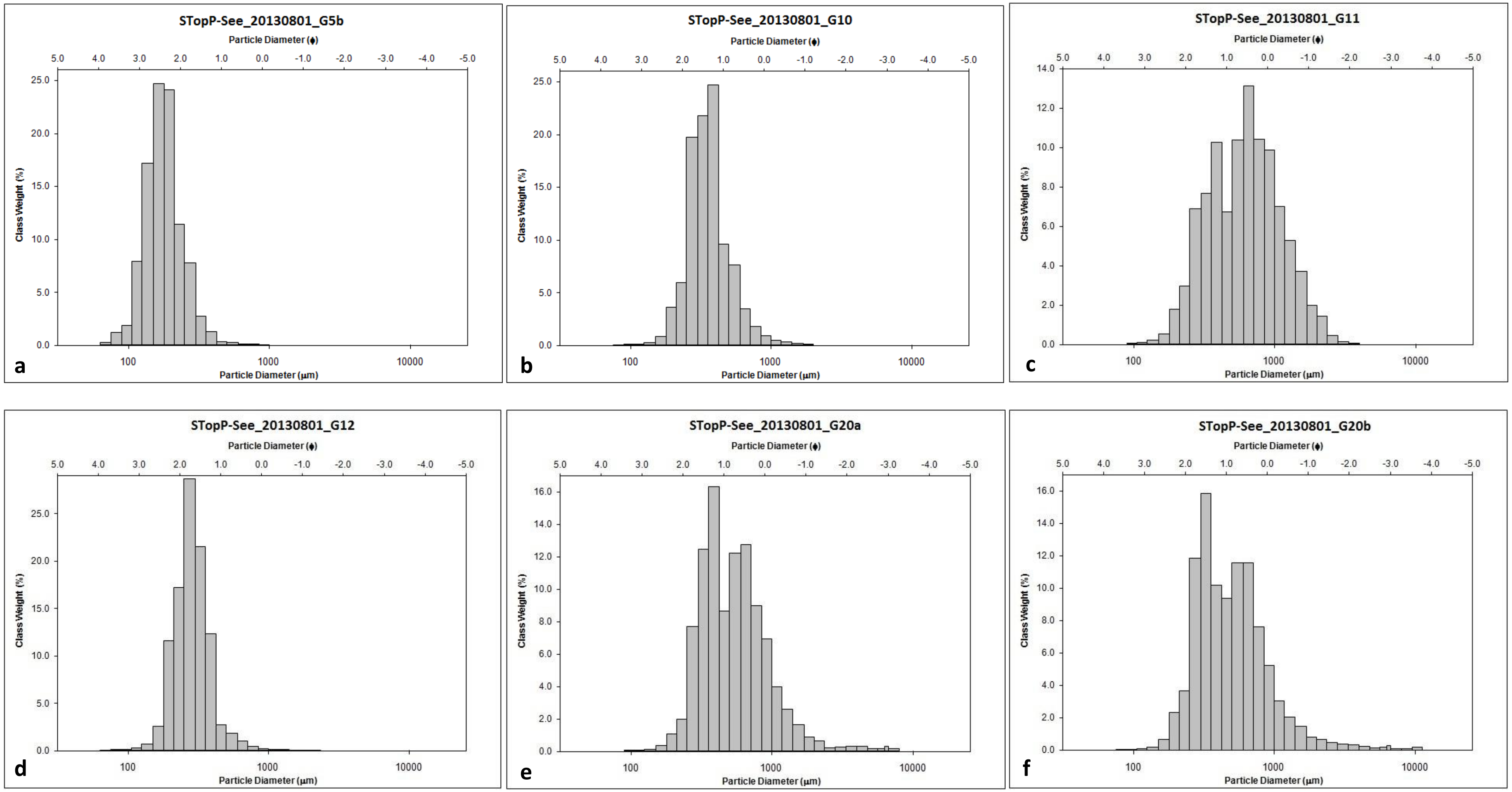

Figure 8 a-f: Grain size distribution of already analyzed grab samples stations 5, 10, 11, 12 and 20

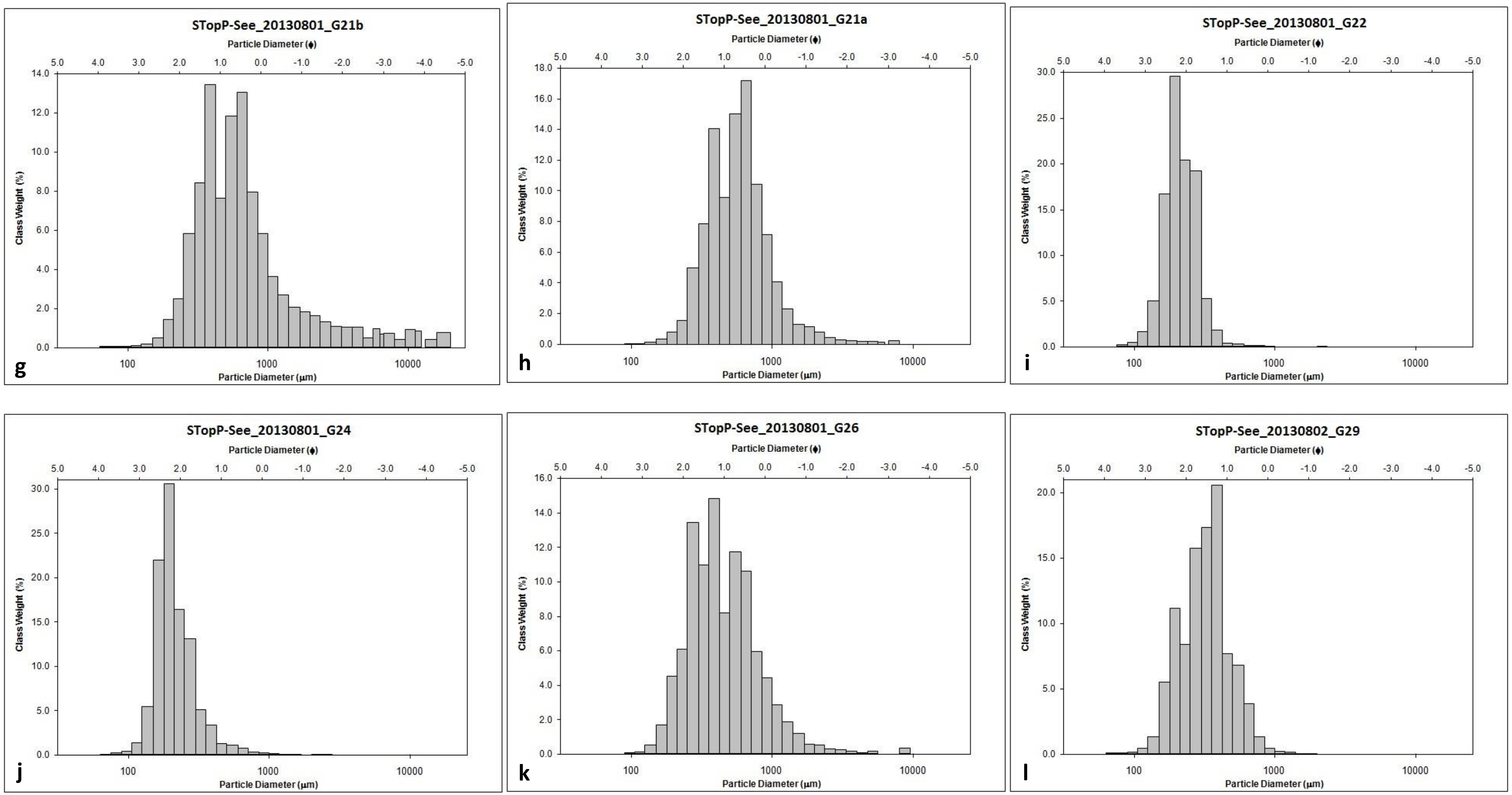

Figure 8 g-l: Grain size distribution of already analyzed grab samples stations 21, 22, 24, 26 and 29

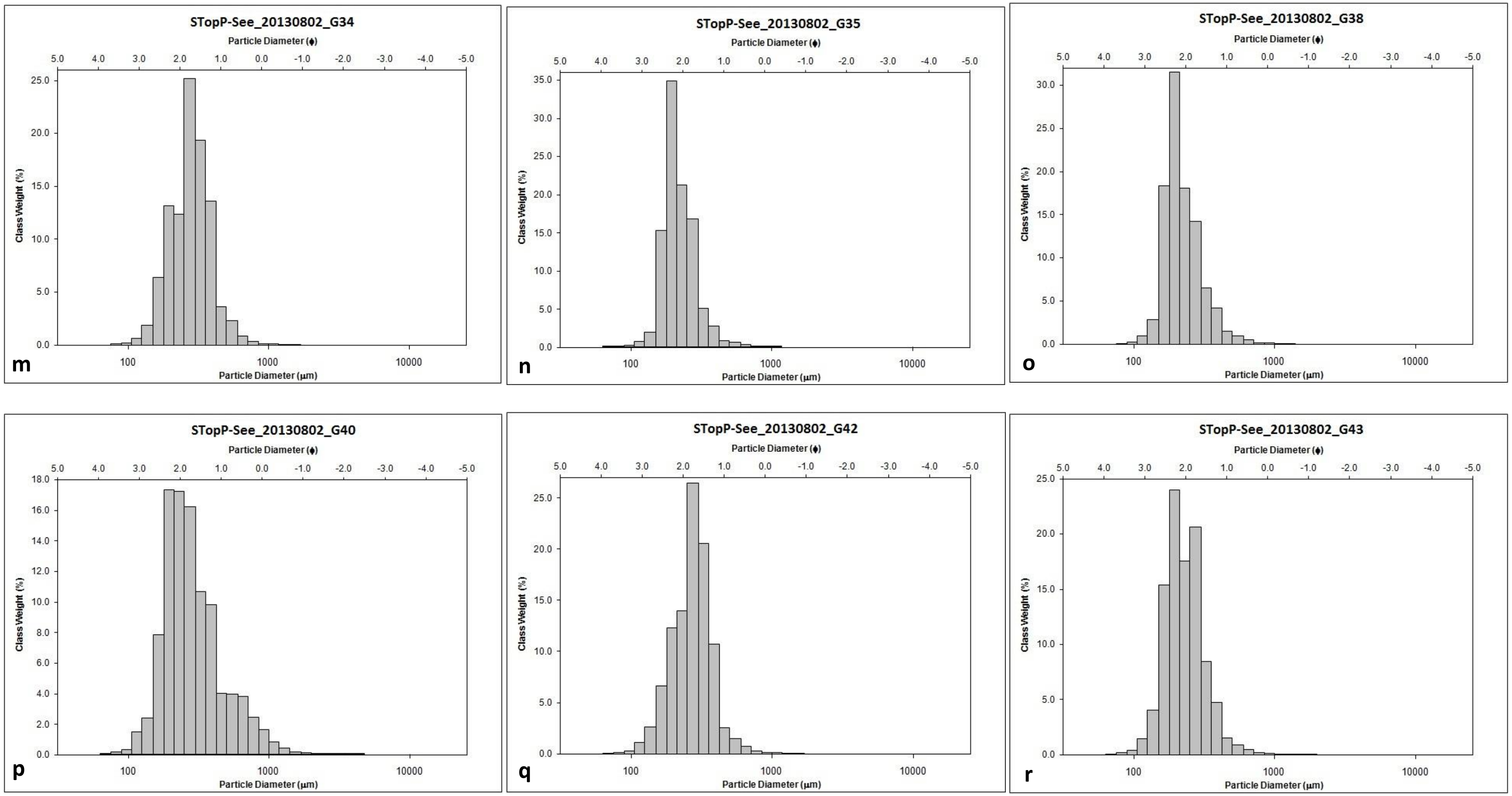

Figure 8 m-r: Grain size distribution of already analyzed grab samples stations 34, 35, 38, 40, 42 and 43